Interactivity in computer-mediated college and university education: A recent review of the literature

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Introduction

Interactivity and interactions are critical in underpinning the learning process in face-to-face, campus based and distance and online education. Interactions serve a diverse range of functions in the educational process which include, for example:
- promoting active and participative learning on a one to one basis or within a group or learning community through social dialogue;
- enabling effective facilitation of learning to suit individual learner's needs and learning styles;
- allowing learner input to the learning process as well as enabling learners to take ownership and control of their learning;
- enabling the development of higher order knowledge and abilities, for example critical thinking, problem solving, judgement -/decision-making skills, reflection, etc.;
- providing effective feedback to inform on the teaching and learning process as well as enhance the quality and standards of the learning experience (Fahy, 2003; Juwah, 2003

The rapid evolution of the information and communications technologies (ICT) and the Internet has contributed significantly to the phenomenal growth of distance and online education. Educational research findings suggest that the success of any educational process is and should be underpinned by sound pedagogical principles and interactions. Our brief overview of literature will highlight some trends and developments in the study of interactivity and interactions in distance and online education.

Defining Interactivity

The search for an educationally viable definition of interactivity has produced some valuable insights for distance educators. Interactivity and interactions in online education are complex, multifaceted phenomenon and are critical in promoting and enhancing effective learning (Anderson, 2002; Hirumi, 2002; Sims, 1995; Yacci, 2000).Yacci (2000) describes four major attributes to interactivity:
- Interactivity is a message loop;
- Instructional interactivity occurs from the student's point of view and does not occur until a message loop from and back to the student has been completed;
- Instructional interactivity has two distinct classes of outputs: content learning and affective benefits;
- Messages in an interaction must be mutually coherent (p. 6).

Yacci's reflections reveal the existence of a student-centered orientation around their perceptions of interactivity. Therefore, a web based educational program can claim interactivity but students will not acknowledge interaction until they individually receive some form of feedback. Yacci's observations emphasis the need to

study online interaction from a communication theory perspective by investigating a diversity of variables such as length and number of messages, type of information shared and the amount of time between responses.

Muirhead (2000) offers a practical definition of interactivity, which affirms the human dimension of this term; interactivity refers to communication, participation, and feedback. Additionally, interactivity involves participation by the learner in online communication with other learners and with their instructors. The definition highlights the personal nature of sharing information during an online class. Naturally, students interact with their course materials through reading textbooks, journals and discussion forum comments from other students and their instructors. The subject matter provides an academic foundation for meaningful dialogue within a distance education class.

From the above definitions, it is clear that interactivity is a multifaceted concept and can be described to mean different things in a variety of contexts. Nevertheless, it is recognised as an important and critical characteristic in instructional design, social context and success of distance education (Beard and Harper, 2002). Thurmond (2003) shares an insightful definition of interaction:

The learner's engagement with the course content, other learners, the instructor, and the technological medium used in the course. True interactions with other learners, the instructor, and the technology results in a reciprocal exchange of information. The exchange of information is intended to enhance knowledge development in the learning environment. Depending on the nature of the course content, the reciprocal exchange may be absent – such as in the case of paper printed content. Ultimately, the goal of interaction is to increase understanding of the course content or mastery of defined goals (p. 4).

To add to this debate, the authors based on their understanding and experience from practice share relevant definitions of interactivity and interaction as follows:

Interactivity

Interactivity in distance and online education describes the form, function and impact of interactions in teaching and learning.

Interaction

Interaction is a dialogue or discourse or event between two or more participants and objects which occurs synchronously and/or asynchronously mediated by response or feedback and interfaced by technology. The interactions which can be categorised as learner to learner, learner to content, learner to tutor, learner to technology, tutor to content, tutor to technology, content to content, promote and enhance quality of active, participative learning in a learning environment (See figure 1).

Types of Interactions

There exists in the literature an array of taxonomies for categorising interactions. Several authors have identified four primary types of interactions. These are - student-student, student-teacher, student-content, student-interface (Anderson 2002; Hirumi, 2002; Rovai, 2002; Sims, 1995). Sims (1995) provides a valuable classification of interactivity based on an instructional courseware designer's perspective. This classification demonstrates both the importance and integrated aspects of the various concepts in enhancing motivation, engagement and instructional transactions in technology-enhanced education. The following descriptions depict the range and characteristics of the interactive concepts:

Object Interactivity: (proactive inquiry) refers to an application in which objects (buttons, people, and things) are activated by using a mouse or other pointing device to elicit an audio-visual response.

Linear Interactivity: (reactive pacing) refers to applications in which the user moves through predetermined linear sequence of instructional material without any response-specific feedback to learner's actions. This type of interaction is referred to as "page-turning".
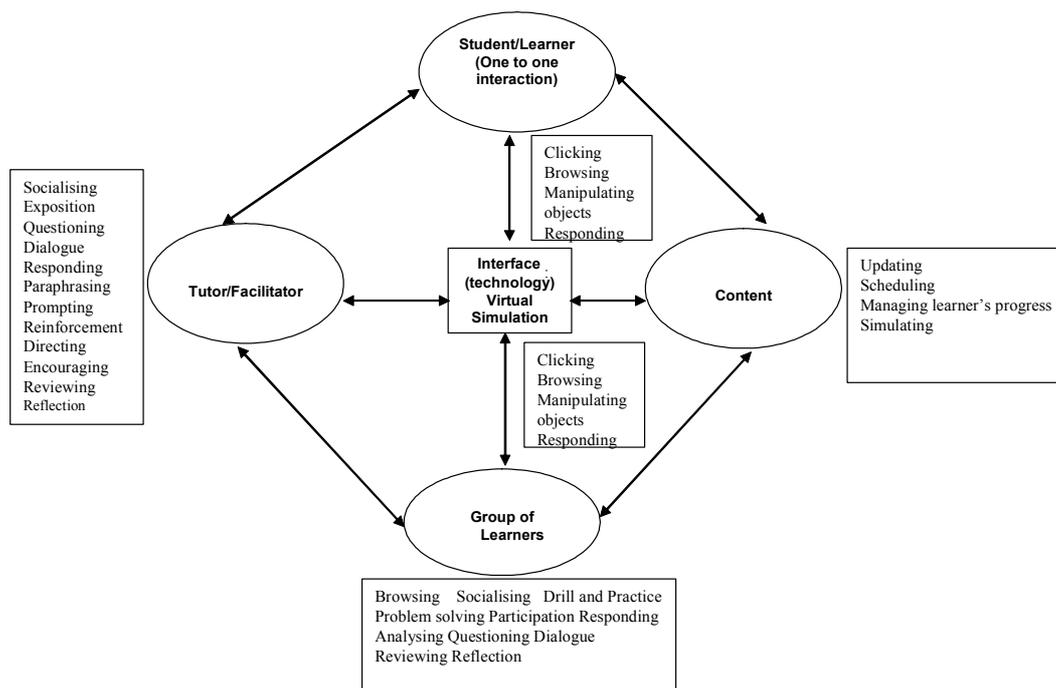
Figure 1. Model of Interactivity

Support Interactivity: (reactive inquiry) provides learners with performance support in both generalised and context-sensitive perspectives.

Update Interactivity: (proactive) relates to individual application components or events in which a dialogue is initiated between the learner and computer-generated content. This may involve applications which present or generate problems or dialogues to which the learner must respond. The learner's response will result in a computer-generated update or feedback. The instructional rigour of the judging will determine the extent to which the update or feedback provides a meaningful response to the user.

Construct Interactivity: (proactive elaboration) involves learner in manipulating component objects to achieve specific goals and/or outcomes. This type of interaction provides a link between non-situated learning and simulated environments, and introduces the learner to authentic learning situations without the risks or costs involved with "real life situations".

Reflective Interactivity (proactive elaboration) refers to interactions in which users' entered responses to a task are compared to the responses of other users as well as recognized "experts", thus enabling the learners to reflect on their response and make their own judgment as to its accuracy or correctness.

Simulation Interactivity:(which ranges from reactive elaboration to mutual elaboration, depending on its complexity) involves the learner in manipulating "non-real" objects to obtain desired goals in a training sequence. Sims (1995) posits that simulation and construct interactivity levels are closely linked, and may require the learner to complete a specific sequence of tasks before a suitable update can be generated. The interaction sequence can also be varied for example, allowing the learner to progress to other stages of learning/activity only after making a correct choice.

Hyperlinked Interactivity: (proactive navigation) provides the learner access to a wealth and diverse range of information linked to a knowledge base.

Non-Immersive Contextual Interactivity: (mutual elaboration) provides the virtual environment in which users/learners engage in meaningful learning in a job-related context through a series of content oriented sequences.

Immersive Virtual Interactivity: (mutual elaboration) provides a complete computer-generated, virtual reality interactive environment in learning based on interactions between the user's actions and response and feedback from within the learning environment.

He concluded his classification by proposing an engagement-control model of interactivity. The model consists of **engagement** which is instructional or navigational, **control** wherein the program or learners is in control of making the instructional/navigational decisions and the **interactive** concept provides an indication of the type of interaction expected under the particular context.

Hirumi (2002) provides a concise summary of the categorisation of interactions as"communications-based"; "social"; "roles of the instructor", "purpose-based"; "use of telecommunication tools"and"activity-based". In addition, Hirumi (2002) highlights the importance of sound educational principles, cognitive learning theories and grounded instructional strategies to inform course design and sequencing of activities to ensure effective interactions, thereby, making learning relevant, meaningful and authentic.

However, to support authentic learning as well as enhance the learner's educational experience in distance and online courses, it is imperative to provide adequate scaffolding. The epistemological approach in providing appropriate scaffolding to support deep learning in the diverse range of interactions can be via – manipulating objects and symbols, questioning, dialoguing, analysing, netweaving, representing, i.e. presenting and structuring activities and guiding learner's reflection within appropriate contexts. These scaffoldings can be categorised as:

Conceptual: These guide the learner in what to consider, particularly when the problem/task is defined. They provide explicit hints and examples.

Metacognition: These guide the learner on how to think in considering the problem/strategies, for example, framing the problem. These provide suggestions to plan ahead, model cognitive strategies, regulatory process and evaluation.

-Procedural: These guide the learner on how to utilise information – i.e. provide on-going help and advice, and may include tutoring.

Strategic: These guide the learner in analysing and approaching the problem with a strategy. These provide a start up to seeking solutions, as well as enabling focused responses to the problem situation (Juwah, 2002).

Cognisant of the role of interactions in education and drawing from experience and other research studies, Anderson (2002, paragraph 10) goes on to develop an "Equivalency theorem" that states:
Sufficient levels of deep and meaningful learning can be developed as long as one of the three forms of interaction (student-teacher; student-student; student-content) are at very high levels. The other two may be offered at minimal levels or even eliminated without degrading the educational experience. High levels of more than one of these three models will likely deliver a more satisfying educational experience, though these experiences may not be as cost or time effective as less interactive learning sequences.

Our search and review of the literature highlights six primary types of interactions within which a variety of secondary interactions and activities are embedded. These categories are:
➢ student-student;
➢ student-teacher;
➢ student-content;
➢ student-interface;
➢ teacher-teacher;
➢ content-content.

Notwithstanding the plethora of categorizations of interactions, one thing was obviously clear in the literature. There is no single medium that is superior to the others in supporting the learners's needs and their educational experience via the provision of various types of interactions. However, each type of instructional interaction

plays a role in the entire educational process, with the process being more effective if predicated on a blend of interactions.

Educational Implications

Research has shown that the use of ICT and multimedia in both verbal and non-verbal forms improve and facilitate learning through reducing cognitive load. It provides the right context and an integrated learning environment that combines the use of the Web and an appropriate mix of multiple - and/or multi-media e.g. animation, audio, images, video, CD, print and hypertext to give a rich, stimulating and interactive learning environment. The media mix enhances learner motivation and has the potential of meeting the needs of the different learning styles – visual (images), auditory (sound), tactile (touch) and kinaesthetic (whole being). However, it is critical that in designing a learning environment in which ICT is used to support learning that such an environment has the ability to synchronise and coordinate diverse multimedia elements (Juwah, 2002).

Research studies on constructivism and interactivity point to some interesting preliminary results. Taylor and Maor (2000) studied a graduate online class at Curtin University of Technology, Perth, Australia. The research project created a questionnaire known as the Constructivist On-Line Learning Survey (COLLES) to measure both teacher and student perceptions in the following six categories:
➢ **professional relevance-** the extent to which engagement in the on-line classroom environment is relevant to students's professional worldviews and related practices;
➢ **reflective thinking**- the extent to which critical reflective thinking is occurring in association with online peer discussion;
➢ **interactivity**-the extent to which communicative interactivity is occurring on-line between students and between students and tutors;
➢ **cognitive demand**- the extent to which communicative interactivity is occurring on-line between students and tutors;
➢ **affective support**- the extent to which sensitive and encouraging support is provided by tutors;
➢ **interpretation of meaning**- the extent to which students and tutor co-construct meaning in a congruent and connected manner (Taylor and Maor, 2000, paragraph 4).

Student expectations were met in five of the six categories except in the area of interactivity. A revealing finding was the absence of dynamic dialogue in the class which had structured small group activities that included a systematic change of student leaders and topics. Student online remarks were one-dimensional commentaries that failed to address comments made by their colleagues. The study indicated teachers must create a learning environment that equips students with instructional experiences to enhance their reflective skills. Additionally, students must be dedicated to becoming more sophisticated learners who are willing to learn from their colleagues while cultivating an intellectually engaging writing style that fosters academic discussion.

It is clearly evident from the literature that interactions are critical for enhancing motivation, communication, a diverse range of skills and intellectual development in the educational process. However, the lack of proper integration between pedagogy, organization and technology has often resulted in some distance and online education being delivered as correspondence courses, with the consequence that such courses lack interactivity, immediacy and appropriate tutor feedback. Such a phenomenon has led Garrison and Anderson (2003) to state "educators have not understood and capitalized on the blend of symbol systems, such as multimedia, text-based communication systems that create new modes of expression and communication" (p. 4).

Further Research

Information available in the literature on research into the complex phenomenon of interactivity and interactions is rather limited in scope due to the lack of theory to guide research projects (Anglin & Morrison, 2003). Berge and Mrozowski (2001) in their survey of research articles from four technology journals for the period 1990-1999, identified the following research trends:

Most attention-over 100 articles were focused in three categories
➢ design issues
➢ strategies to increase interactivity
➢ learner characteristics

Least attention was paid to
➢ learner support
➢ equity and accessibility
➢ cost/benefit trade-offs

Interactivity has been a major focus for researchers but much more needs to be done. Interactions online occur within a learning community and such communities provide an important area for research, in terms of the nature of collaboration and interactions within the community of learning. The issue of learner support is connected to related topics such as student attrition. For instance, what are the most effective types of learner support? Motivation and engagement are critical factors for effective learning. The challenge here is to investigate the pedagogy of engagement and interactions through electronic simulation or virtual reality in enhancing learner's experience.

Conclusion

This literature review highlights the multifaceted nature of the concept of interactivity and interactions, as well as the importance of interactions in underpinning distance and online education. It briefly highlights the fact that interactions are not solely the manipulation of symbols and representation but the promotion of metacognition (reflection) which is critical in meaning making and construction of new knowledge. Additionally, the review also highlights insights from online teaching experiences that will help inform current theories and generate ideas to develop new theories (Anglin & Morrison, 2003).

Discussion Questions
1. What types of interactions provide the best educational experiences for online students?
2. What are the most effective ways to facilitate student collaboration online?
3. What teacher practices encourage positive communication within the online class?

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Post-discussion Summary

The discussion began with concerns about creating an accurate definition of interactivity that clearly describes the human interactions in the online environment. Writers have developed several taxonomies of online interactions but it is still a work in progress. The dialog did engage in an assortment of interactivity issues such as relevant pedagogical activities**,** teacher competencies, teacher training, instructional design considerations and classroom management.

Research studies on interactivity reveal a multidimensional entity that often requires more investigation. The following IFETS discussion highlights as well as reflects a rich diversity of thought on interactivity in computer-mediated classes.

Marshal Anderson- raised concerns that instructional designers must work harder at developing e-learning platforms that meet legitimate student needs.

Richard Dillman- discussed reasons why students drop out of their online classes and observed that it takes time for online teachers to adopt and modify their instructional techniques. "Just as it requires some new skills to study online, so does it require new teaching skills? If we were to be honest about it, we would have to admit that some teachers still have some work to do in that regard."

Anita Pincas- shared her work as an online instructor at the University of London and how teachers can transfer traditional methods into the online environment by using video tapes/cameras and Power Point slides. Anita notes that her "Replication Model" has helped students and educators to make a natural transition to the online setting.

Hans Horwath- argues for creating unique online courses that are truly different from the traditional face-to-face classes and suggests creating an international forum as one way to bring diversity into cyber classes.

Barry Porter-stressed the importance of student motivation and having his online masters degree accepted for a doctoral program.

Bob Valiant- noted how individuals are already managing their own learning more than we probably realize and shared a web site for one of his articles on this vital subject.

Hai Zhang- outlined potential ways to discuss the transfer of information online such as data mining, cultural analysis, media communication and cognitive science.

Marsha Hammond- shared the importance of instructors communicating clearly in their online courses through written messages. Marsha spoke about variability of student involvement in online discussions and the desire to discuss this issue.

Wang Xiuwen- stressed the need to individualize student assessments and the importance of recognizing student learning styles in the teaching and learning process.

M. Yasar Ozden-obvserved that his online class requires much more work than his traditional classes. The human and social dimension of learning is very important to the online learning process which affirms the need for diligent and trained instructors. He raised thoughtful questions about the daily online management strategies of teachers and whether online teacher competencies differ from the traditional teacher skills.

Ania Lian-suggested that those concerned with the constructivist perspectives of online teaching should focus more attention on how their instructional practices influence their student's ability to form or build reality/knowledge. Ania raised a vital question, "what makes our definition of interaction challenge our teaching rather than being subservient to our prejudices?"

Anthony Trippe- noted how he fosters active participation in his online classes through his grading procedures which place a strong value on student participation.

Mark Nichols-raised questions about the nature of interactivity and proposed that the concepts of "object" and "linear" should be classified as types of content navigation and not interactivity.

Bronwyn Hegarty- explored the five different threads in our IFETS interactivity discussion to examine the coherence of our dialog.

Eshaa M. Alkhalifa- raised an assortment of reflective questions about online assessment involving the teaching and learning process and shared insights from researchers on several issues.

Mary Hall- shared a detailed overview of our discussion to highlight the temporal nature of interactions while stressing the coherence and purposefulness of our dialog.

Roger Hartley- offered insights into assisting online learners by developing specific student plans based on instructors and students collaborating to create relevant course work. Roger encourages his students to map out their current level of knowledge which helps to identify their genuine learning needs.

Charles Adamson- noted the role of assessment in his Japanese nursing degree program and that the method of assessment must affirm program goals.

Joanna Howard- related how working in an MBA program, collaborative mapping between student and instructors helped accelerate the entire learning process.

Alfred Bork- emphasized the issues of frequency and quality of online interactions. He suggested the key to increasing individualized education was creatively using the computer as an adaptive tool to communicate at a global level. He noted that adaptive tutorial learning could be quite useful for China and it has larger implications due to the shortage of teachers.

Ramesh Sharma- shared recent research studies on interactivity which revealed how online instructors brought a human dimension to their classes to create cyber communities.

Eric Flescher- related a concern about the weakness in current Internet based instructional activities that do not encourage students to do original and reflective work . "Teachers many times either make the activities too structured or too flexible and fail to use various multiple intelligence mode based activities (drawing, group, visual, mathematical etc) to supplement their activities."

Bill Williams- addressed a host of interactivity issues involving creating an appropriate and stronger interactivity definition which avoids excessive generalizations and simplistic identification of basic interactions (i.e. reading), importance of properly assessing online learning, solitary learners represent a smaller portion of students who have few interaction expectations and critical multimedia and task design. He made a very relevant observation that "I believe course design and more specifically task design is a key factor here and I am concerned that this meta-structural aspect may be in danger of being neglected if our attention is focused mainly at the interaction level."

Wang Xiuwen- related the importance of online instructors providing adequate guidance for their students when using a student-centered instructional model. It takes time for teachers to change from traditional teaching methods to technology oriented learning strategies.

M. Goswamy- stressed the need to develop an educational online environment that promotes a sense of "openness" by stimulating student questioning and inquiry during online interactions. "It is, therefore, essential that the contents and the interaction are not only linked and complimentary but also supplementary in nature."

Bob Cavenagh- observed that culture can play a role in online interactivity. "I deal with some students from other cultures and have gradually recognized that their occasional unwillingness to participate in some situations stems from cultural values, not from shyness, linguistic shortcomings, or lack of ability."

Terry Anderson - shared the idea of "equivalency theorem" which provides a rationale for concentrating on learner needs for different types of interaction (time and geographic constraints etc.) and the cost implications of each type.

The diverse range of factors covered in the discussion reflected the role and importance of interactivity in underpinning and enhancing learners' educational experience. The issues raised in the discussion thus focuses the mind as well as challenges educators and researchers to engage more with and to continually research and gain a better understanding of this critical phenomenon that can impact very significantly on the quality of the learning process. To that end, the areas highlighted from our discourse for further research include:

➢ Designing of learning environments to support quality interactions;
➢ Course design to ensure appropriate content and effective sequencing of activities to promote quality interactions and learning to meet individual needs;
➢ The role and impact of media on interactivity and cognitive load;
➢ Teacher competencies and roles in enhancing interactivity in the learning environment whilst paying particular attention to individual student's needs;
➢ Using assessment to underpin and promote effective interactions in learning situations;
➢ Impact of culture and/or cultural factors in classroom interactions and learning;
➢ Cost benefit analysis of designing interactivity into courses whilst maintaining quality learning**.**